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MILITARY POTENTIAL TEST OF SG-100 SLAVED GYRO COMPASS SYSTEM.(U)
OCT 66 M H CROWELL, E B SMITH

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(9) Final Report of Test
9 Jun - 15 Aug 66,
by

(10) Captain Mark H. Crowell
Mr. Earl B. Smith

(11) 10 October 1966

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DEPARTMENT OF THE ARMY
UNITED STATES ARMY AVIATION TEST BOARD
Fort Rucker, Alabama 36360

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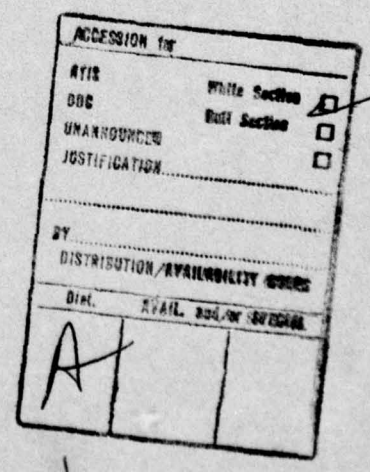

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ABSTRACT

The US Army Aviation Test Board tested the SG-100 Slaved Gyro Compass System to determine its military potential for use in O-1( ), U-1( ), and U-6( ) airplanes as a replacement for the Gyro Directional Indicator, AN5735 series. The test was conducted at Fort Rucker, Alabama, during the period 9 June 1966 through 15 August 1966. The test items were installed in a U-1A and a U-6A Airplane and were operated 50 and 250 flight hours, respectively. An O-1( ) airplane was not available for the test. The SG-100 was operationally superior to the AN5735-1 during en route and terminal area flights, but was subject to the same gyro limitations as the AN5735-1 during tactical missions where a high degree of maneuverability was required. No deficiencies were found during the test. Two shortcomings were found. It was concluded that the SG-100 has military potential as a replacement for the AN5735-1, and that correction of the shortcomings would enhance the military potential. It was recommended that the shortcomings be corrected as technically and economically feasible, and that the SG-100 be service tested.

FOREWORD

The Commanding General, US Army Test and Evaluation Command (USATECOM), directed the military potential test of the SG-100 Slaved Gyro Compass System in letter, AMSTE-BG, Headquarters, USATECOM, 19 April 1966, subject: "Test Directive, USATECOM Project No. 4-6-3262-01, Military Potential Test, Slaved Gyro Compass System SG-100," as amended by letter, AMSTE-BG, Headquarters, USATECOM, 17 August 1966, subject: "Revision to Test Directive, Military Potential Test, Slaved Gyro Compass System, SG-100, USATECOM Project No. 4-6-3262-01."

The US Army Aviation Test Board (USAAVNTBD) was responsible for planning and conducting the test and for reporting the test results.

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SECTION 1 - INTRODUCTION

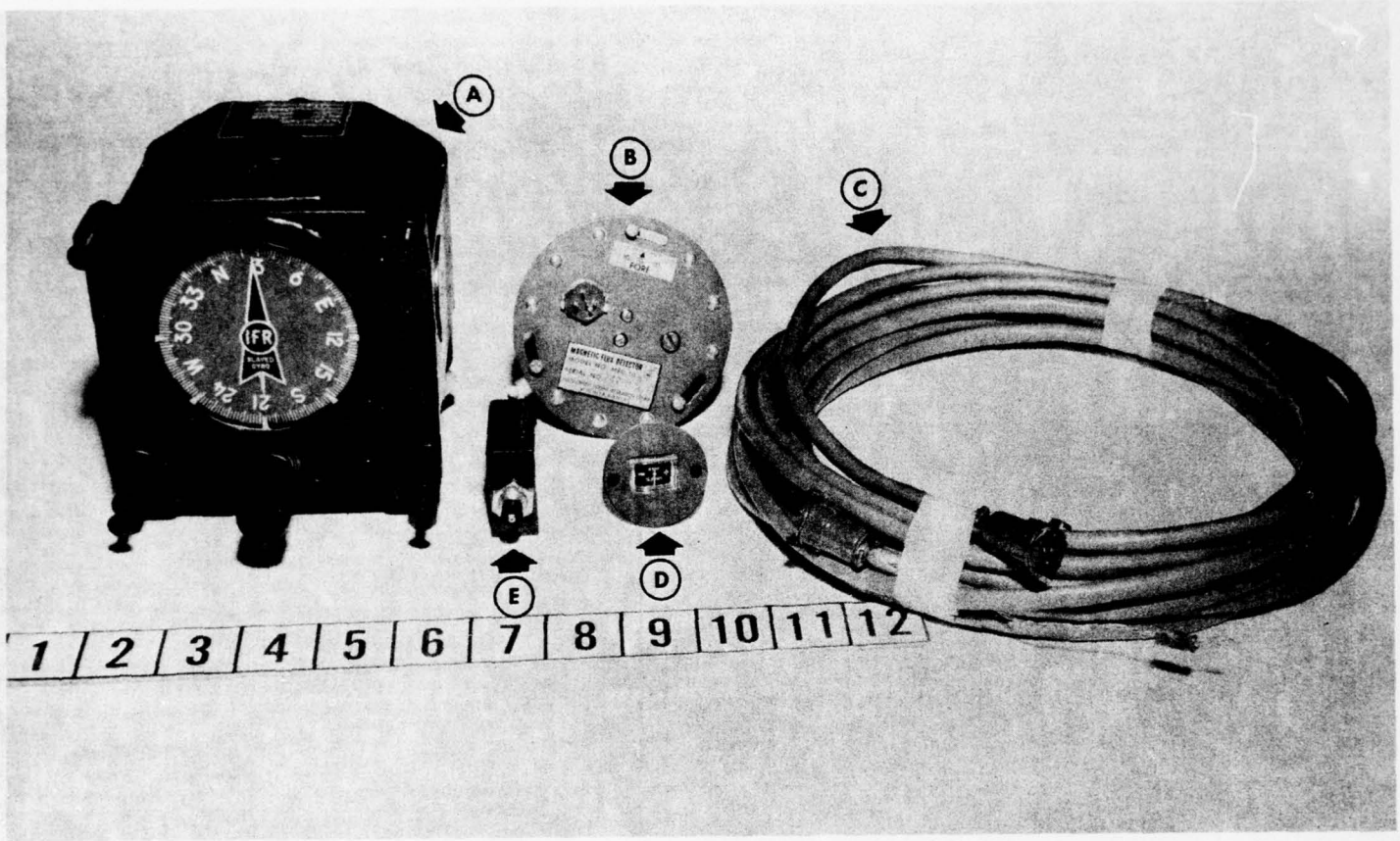

Figure 1. SG-100 Slaved Gyro Compass System
Arrow A: Gyro Indicator Arrow C: Cabling
Arrow B: Flux Detector Arrow D: Slaving Indicator
Arrow E: Circuit Breaker

1.1. BACKGROUND.

1.1.1. Army airplanes of the O-1 and U-6 series are equipped with a vacuum-driven gyro as a stabilized heading reference. Commonly designated the AN5735-1 Gyro Directional Indicator, these units, as produced by different manufacturers, have varied somewhat in physical characteristics; weight, for example, has ranged from 2.5 to 4.5 pounds. The operational procedure for this heading reference, which consists of a horizontal gyro operating in a free mode, requires that prior to takeoff, the pilot manually align the gyro-driven indicator card with the liquid-filled magnetic compass, and subsequently realign the indicator card manually as often as required during flight. The nominal frequency of in-flight verification of agreement between the gyro directional indicator and the magnetic compass is once each 15 minutes. This period depends upon the drift rate (precession) which is inherent in the gyro design, and which is increased as a result of wear.

1.1.2. The aviator uses primary information from an instrument which is dependent upon his accuracy in initial and subsequent adjustments and his continuous visual monitoring to insure agreement with the liquid-filled magnetic compass. The undesirable aspects of this procedure are compensated by the less demanding requirements of a heading reference system as a function of the tactical mission of these particular airplanes.

1.1.3. The U-1A includes in its standard configuration a slaved-type gyro compass system, the AN/ASN-13, which weighs approximately 8.5 pounds.

1.2. DESCRIPTION OF MATERIEL.

The SG-100 Slaved Gyro Compass System is designed to provide accurate drift-free compass headings for light aircraft. The system consists of an air-driven gyro indicator, a slaving indicator, and a remotely mounted magnetic flux detector. The slaving indicator provides positive indication of system operation and also provides a means for the pilot to establish a precise heading before takeoff. The indicator provides a rotating vertical-card presentation of heading. The magnetic flux detector can be mounted in the aircraft in any location free of aircraft-induced magnetic effects. The system will operate in free DG or slaved mode. A lightweight electronic package is mounted in the gyro housing to provide the slaving function. System weight is 4.85 pounds.

The electrical power requirement is 0.25 ampere at 28-volts direct current (v.d.c.).

1.3. OBJECTIVES.

1.3.1. Purpose.

To determine the military potential of the SG-100 for use in O-1( ), U-1( ), and U-6( ) airplanes as a replacement for the Gyro Directional Indicator, AN5735 series.

1.3.2. Test Objectives.

To determine:

a. Physical characteristics.

b. Installation and calibration requirements.

c. Operational suitability.

d. Maintenance and support requirements.

e. Safety characteristics.

1.4. SUMMARY OF RESULTS.

The test items were installed in a U-1A and a U-6A Airplane and were operated 50 and 250 flight hours, respectively. An O-1( ) airplane was not available for the test (reference 8, appendix II, section 3).

1.4.1. The SG-100 weighed 4.85 pounds, less cabling, and measured 175.33 cubic inches. The maximum electrical power required was 0.25 ampere at 28 v.d.c.

1.4.2. Twenty-three man-hours were required for installation and calibration of the system. Minor modifications were required for each installation. Common tools, equipment, materiel, personnel, and skills normally available at the general-support category were adequate. No special procedures were required for installation and calibration.

1.4.3. The SG-100 was operationally superior to the AN5735-1 during en route and terminal area flights. The SG-100 was subject to the same gyro limitations as the AN5735-1 during tactical missions where a high degree of maneuverability was required.

1.4.4. No unscheduled maintenance was required for the test item during the test period. The electronic package was mounted in the hermetically sealed gyro case, therefore requiring depot-category maintenance.

1.4.5. No safety hazards were found in the test item or the test-bed installations.

1.4.6. No deficiencies were found during the test. Two shortcomings were found.

1.5. CONCLUSIONS.

1.5.1. The SG-100 has military potential as a replacement for the AN5735-1.

1.5.2. The correction of the shortcomings listed in appendix I, section 3, would enhance the military potential of the system.

1.6. RECOMMENDATIONS.

It is recommended that:

1.6.1. The shortcomings listed in appendix I, section 3, be corrected as technically and economically feasible.

1.6.2. The SG-100 be service tested.

SECTION 2 - DETAILS OF TEST

2.1. INTRODUCTION.

The USAAVNTBD conducted the military potential test of the SG-100 Slaved Gyro Compass System at Fort Rucker, Alabama, during the period 9 June 1966 through 15 August 1966. The test items were installed in a U-1A and a U-6A Airplane and were operated 50 and 250 flight hours, respectively. An O-1( ) airplane was not available for the test (reference 8, appendix II, section 3). The SG-100 systems were operated during local and cross-country flights, during daylight and darkness, and during actual instrument flights and simulated tactical missions.

2.2. PHYSICAL CHARACTERISTICS.

2.2.1. Objective.

To determine the physical characteristics of the SG-100 Slaved Gyro Compass System.

2.2.2. Method.

The weight, size, and electrical power requirements of the test item were measured and compared with those of the AN5735-1.

2.2.3. Results.

2.2.3.1. The size and weight of the systems were as follows:

a. SG-100.

	Length (in.)	Width (in.)	Height (in.)	Volume (cu. in.)	Weight (lb.)
Gyro indicator (figure 2)	7.00	4.50	5.00	157.50	4.50
Magnetic flux detector (figure 3)	2.25	3.25	2.25	16.43	0.30
Slaving indicator (figure 4)	1.25	1.50	0.75	1.40	0.05
		TOTAL		175.33	4.85*

*Less cabling

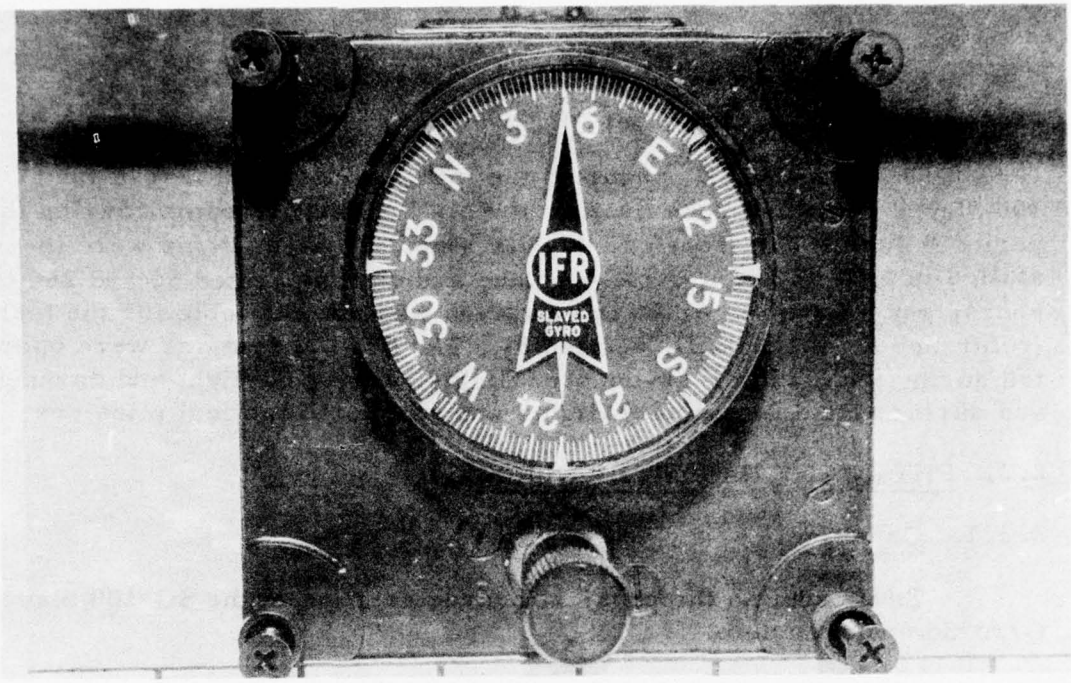

Figure 2. Gyro Indicator

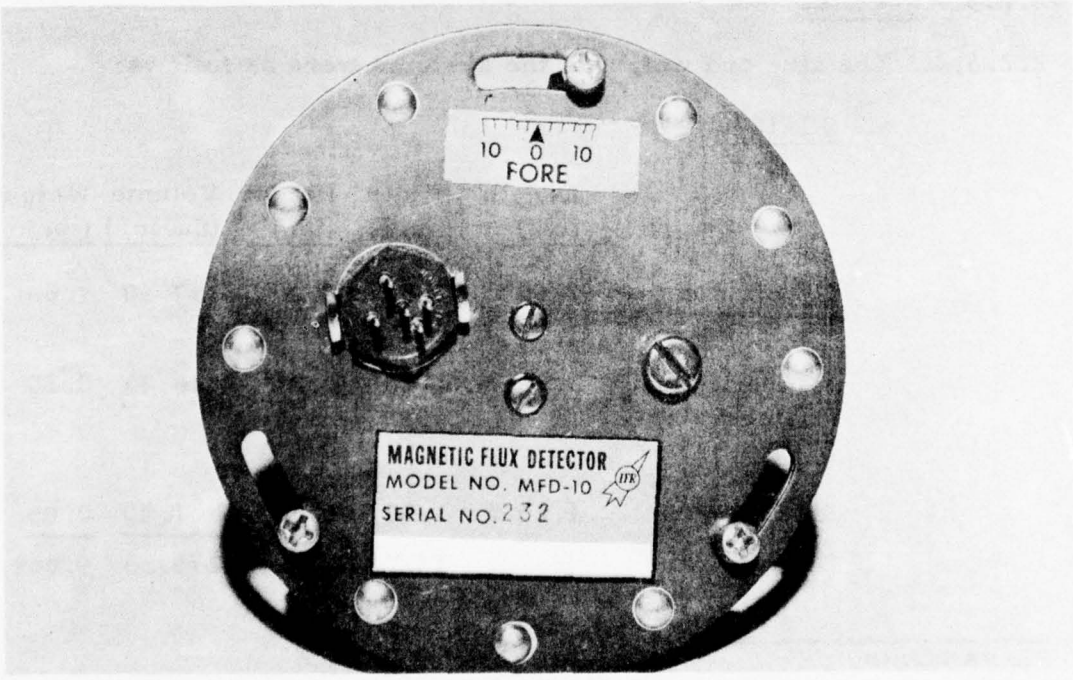

Figure 3. Magnetic Flux Detector

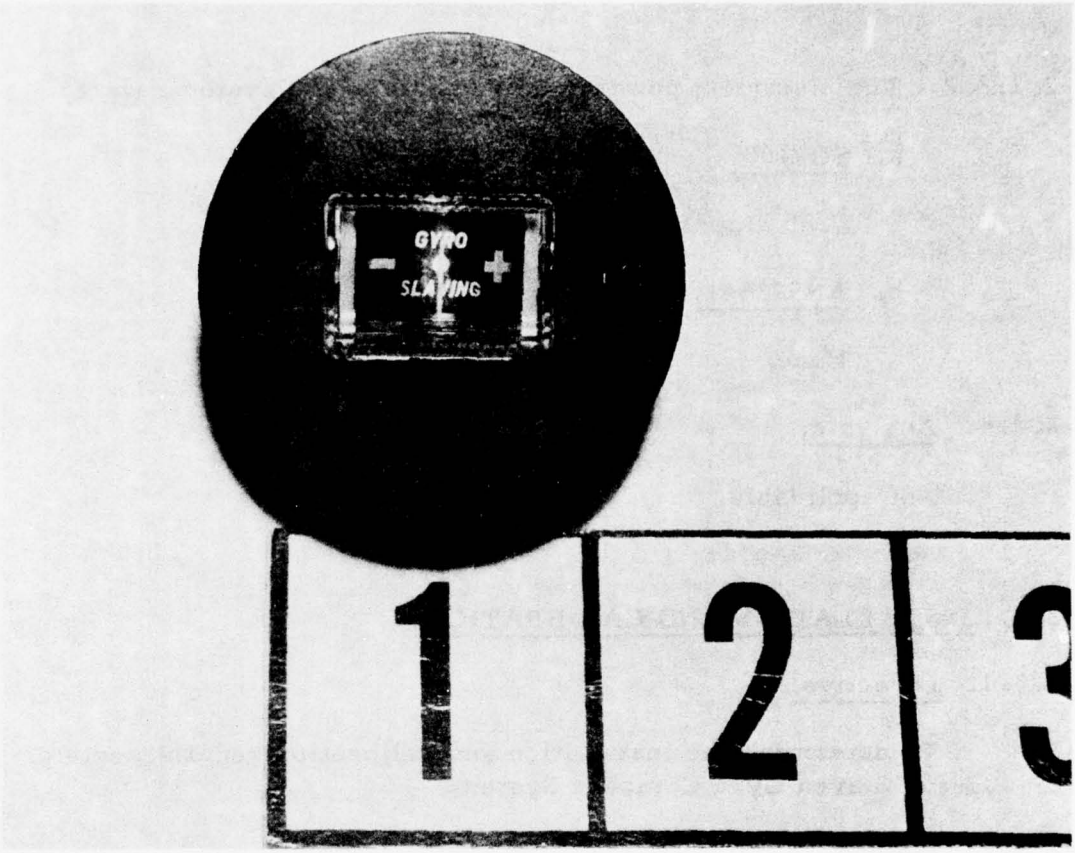

Figure 4. Slaving Indicator

b. AN5735-1.

	Length (in.)	Width (in.)	Height (in.)	Volume (cu. in.)	Weight (lb.)
Gyro indicator	7.00	4.75	5.00	166.25	4.00

2.2.3.2. The electrical power requirements of the systems were:

a. SG-100.

0.25 ampere at 28 v.d.c.

b. AN5735-1.

None.

2.2.4. Analysis.

Not applicable.

2.3. INSTALLATION AND CALIBRATION.

2.3.1. Objective.

To determine the installation and calibration requirements of the SG-100 Slaved Gyro Compass System.

2.3.2. Method.

The SG-100 systems were installed in U-1A and U-6A Airplanes and calibrated after each installation. Tools, equipment, materials, aircraft modifications, procedures, personnel skills, and time required for installation and calibration were recorded.

2.3.3. Results.

2.3.3.1. Common tools and equipment authorized at general-support category of maintenance were adequate; no special tools were required.

2.3.3.2. Approximately 20 man-hours were required by sheet metal and electrical personnel to install the test item in each airplane. Three man-hours were required for calibration of the test item in each airplane. No special procedures were required.

2.3.3.3. Minor modifications to the airplanes were required for mounting indicators and the magnetic flux detectors. No installation incompatibilities were found.

2.3.4. Analysis.

Common tools, equipment, materials, personnel skills, and procedures normally available at the general-support category were adequate for installation and calibration of the test item.

2.4. OPERATIONAL SUITABILITY.

2.4.1. Objective.

To determine the operational suitability of the SG-100 as installed in U-1A and U-6A Airplanes.

2.4.2. Method.

The SG-100 was flight tested in each airplane during hours of daylight and darkness, on and off the civil airways, in actual instrument flights and approaches, and in simulated tactical missions. For determining the accuracy and the drift rate of the test items, the AN/ASN-13 Gyromagnetic Compass in the U-1A Airplane and the liquid-filled magnetic compass in the U-6A Airplane were used as reference systems.

2.4.2.1. The normal operating procedures of the SG-100 were evaluated and compared with those of the AN5735-1.

2.4.2.2. Flight testing with the system operating in the free directional gyro (DG) mode included straight and level flights at various headings for periods of one hour. Left and right turns of 90, 180, 270, and 360 degrees were made utilizing bank angles of 15 and 45 degrees. Cardinal headings were maintained for 10 minutes, then alternate left and right turns were performed for five minutes. Manuevers of 60 degrees in pitch and roll were performed.

2.4.2.3. The system operating in the slaved mode was used as the primary heading reference for en route and terminal navigational flights.

2.4.2.4. The controls and display of the system were inspected, operated, and evaluated.

2.4.2.5. The operational compatibility of the SG-100 installed in each airplane was evaluated.

2.4.3. Results.

2.4.3.1. Normal operating procedures utilized for the AN5735-1, plus the inherent errors existing in the liquid-filled magnetic compass, resulted in an approximate six-degree error between the actual and indicated heading of the aircraft. The SG-100 constantly indicated headings that were within two degrees of the actual heading.

2.4.3.2. The drift rates of both the SG-100, operating in the free DG mode, and the AN5735-1 varied from 6.0 to 10.6 degrees per hour in level flight. The drift rates of both the SG-100, operating in the free DG mode, and the AN5735-1 varied from 10 to 22 degrees per hour in maneuvering flight.

2.4.3.3. The SG-100 operating in the slaved mode did not exceed two degrees' error over a one-hour period in level flight. The amount of error introduced to the SG-100 while operating in the slaved mode in maneuvering flight could not be accurately determined. The system became synchronized within one minute after the maneuvers were completed, indicating a maximum error of less than three degrees. (The average slaving rate was determined to be 2.8 degrees per minute.)

2.4.3.4. When exceeding the operating limits of both systems (55 degrees), the gyros tumbled, requiring realignment. When maneuvers were to be performed exceeding limits, the AN5735-1 was caged. The SG-100 had no control to provide caging of the gyro.

2.4.3.5. The SG-100 was easier to use for en route and terminal navigation because the rotating card display enabled the pilot to orient himself properly with respect to other navigational aids. The cardinal and inter-cardinal markings of the SG-100 facilitated terminal navigation.

2.4.3.6. The SG-100 was compatible with the aircraft and installed equipment.

2.4.4. Analysis.

2.4.4.1. Since neither the SG-100 nor the AN5735-1 were latitude corrected, both systems should drift at a rate of approximately 7.5 degrees an hour in the Fort Rucker area. On the basis of the latitude of Fort Rucker, the drift rates of both systems were within tolerance.

2.4.4.2. The inability to cage the SG-100 prior to exceeding the limitations was an undesirable feature.

2.4.4.3. The SG-100 was operationally superior to the AN5735-1.

2.5. MAINTENANCE AND SUPPORT REQUIREMENTS.

2.5.1. Objective.

To determine the maintenance and support requirements of the SG-100.

2.5.2. Method.

The SG-100 systems were maintained as necessary during the test period. Operating time, failures, active maintenance downtime, mean time to repair, and replacement parts required were recorded. The SG-100 was evaluated with respect to the ease of maintenance and suitability of calibration procedures. Requirements for any special tools or facilities for support of the SG-100 were recorded.

2.5.3. Results.

2.5.3.1. The test items, installed in a U-1A and a U-6A, were operated 50 and 250 hours, respectively. No failures occurred.

2.5.3.2. Scheduled maintenance was performed and was limited to organizational category. No unscheduled maintenance was performed. Any repair of the SG-100 would require depot-category maintenance because of the hermetically sealed unit.

2.5.3.3. Calibration of the system consisted of a manual-type swing in the airplane, utilizing the compass rose. There was no requirement for special tools.

2.5.4. Analysis.

The requirement to send the test item to depot maintenance in event of failure of the electronic package was undesirable.

2.6. SAFETY CHARACTERISTICS.

2.6.1. Objective.

To determine the safety characteristics of the SG-100.

2.6.2. Method.

The SG-100 systems and the aircraft installations were examined prior to the test and observed during operation and maintenance. Any safety hazards discovered were recorded.

2.6.3. Results.

No safety hazards were noted.

2.6.4. Analysis.

Not applicable.

SECTION 3 - APPENDICES

APPENDIX I - DEFICIENCIES AND SHORTCOMINGS

A. Deficiencies. No deficiencies were discovered during the conduct of this test.

B. Shortcomings. The following shortcomings were discovered during the conduct of this test:

Shortcoming	Suggested Corrective Action	Remarks
1. No capability was provided for locking the gyro in the caged position.	Provide a capability for locking the gyro in the caged position.	While performing maneuvers of roll and pitch at 55°, the gyro would spill and tumble.
2. The electronic package was not accessible for maintenance other than at depot category.	Provide a capability for access to the electronic package at lower than depot category maintenance while still maintaining gyro integrity.	

APPENDIX II - REFERENCES

1. Technical Manual 1-5F8-5-2-14, "Directional Gyro Indicator AN 5735-1," 1 February 1946.

2. Technical Manual 55-6610-205-50, "Directional Gyro Indicator," 30 August 1962.

3. USATECOM Regulation 750-15, "Maintenance of Supplies and Equipment," 16 July 1965.

4. Letter, SMOSM-EGCG, Headquarters, US Army Aviation Materiel Command, 28 January 1966, subject: "Request for Military Potential Test of Slaved Gyro Compass System SG-100."

5. Message, AMSTE-BG 3871, Commanding General, US Army Test and Evaluation Command, 9 March 1966, subject: "Military Potential Test of Slaved Gyro Compass System SG-100."

6. Message, SMOSM-EGC 3-1358, Commanding General, US Army Aviation Materiel Command, 11 March 1966, subject: "Potential Test of Slaved Gyro Compass System SG-100."

7. Letter, Z1456CE-T, Federal Aviation Agency, Central Region, Reply Reference CE-212, 27 April 1966, on the subject of TSO Conformance of the SG-100 Slaved Gyro System.

8. Letter, SMOSM-EGCG, Headquarters, US Army Aviation Materiel Command, 15 June 1966, subject: "SG-100 Slaved Gyro Compass System."

9. Letter, STEBG-TP-V, US Army Aviation Test Board, 21 June 1966, subject: "Military Potential Test of Slaved Gyro Compass System, SG-100, USATECOM Project No. 4-6-3262-01."

10. Letter, SMOSM-EGCG, Headquarters, US Army Aviation Materiel Command, 11 July 1966, subject: "Military Potential Test of Slaved Gyro Compass System, SG-100, USATECOM Project No. 4-6-3262-01."

11. Plan of Test, USATECOM Project No. 4-6-3262-01, "Military Potential Test of Slaved Gyro Compass System, SG-100," Earl B. Smith and John H. Gray, US Army Aviation Test Board, 1 August 1966.

12. "Proposed Test Program, Slaved Gyro Compass System SG-100," Instrument Flight Research Corporation, Inc.

13. "Flying Manual, Slaved Gyro Compass System SG-100," Instrument Flight Research Corporation, Inc.

14. "Instruction Manual, Slaved Gyro Compass System SG-100," Instrument Flight Research Corporation, Inc.

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13 ABSTRACT

The US Army Aviation Test Board tested the SG-100 Slaved Gyro Compass System to determine its military potential for use in O-1( ), U-1( ), and U-6( ) airplanes as a replacement for the Gyro Directional Indicator, AN5735 series. The test was conducted at Fort Rucker, Alabama, during the period 9 June 1966 through 15 August 1966. The test items were installed in a U-1A and a U-6A Airplane and were operated 50 and 250 flight hours, respectively. An O-1( ) airplane was not available for the test. The SG-100 was operationally superior to the AN5735-1 during en route and terminal area flights, but was subject to the same gyro limitations as the AN5735-1 during tactical missions where a high degree of maneuverability was required. No deficiencies were found during the test. Two shortcomings were found. It was concluded that the SG-100 has military potential as a replacement for the AN5735-1, and that correction of the shortcomings would enhance the military potential. It was recommended that the shortcomings be corrected as technically and economically feasible, and that the SG-100 be service tested. (U)

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Fort Rucker, Alabama	Deficiencies						
Military potential test	Shortcomings						
SG-100 Slaved Gyro Compass System							
AN5735-1 Gyro Directional Indicator							
U-1A and U-6A Airplanes							
Gyro indicator							
Magnetic flux detector							
Slaving indicator							
Physical characteristics							
Installation and calibration							
Operational suitability							
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14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

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